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Original Article

STUDY OF CGMS BASED PIGEONPEA [*Cajanus cajan* (L.) Millsp] HYBRIDS IN TERMS OF COMBINING ABILITY

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ABSTRACT

To ascertain combining ability 30 hybrids were made from 13 parents in a line X tester mating design during kharif, 2012-13 and tested in a Randomized Block Design with two replications during kharif, 2013-14. Analysis of variance for quantitative traits revealed that all accessions were significantly different and a wide range of variability exists for most of the traits studied. Most promising combinations for seed yield per plant were ICPA 2047 x ICPL 20126, ICPA 2048 x ICPL 20106, ICPA 2047 x ICPL 20108 and ICPA 2047 x ICPL 20098. The general combining ability revealed that among the testers, ICPL 20126 and ICPL 20108 were good general combiners for seed yield/plant. The results also revealed that some crosses exhibited high order significant and desirable SCA effects for different characters involved parents having different GCA effects.

***KEYWORDS:** Pigeonpea, General Combining Ability, Specific Combining Ability and CGMS*

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INTRODUCTION

The total pulse production in India was 17.21 million tonnes from an area of 24.78 million ha and productivity being, 694 kg/ha, which is still short of the present consumption of ~19 million tonnes and thus forcing the country to import pulses to the tune of 1.5-2.0 million tonnes annually (https://www.agricoop.nic.in, accessed on Feb. 28, 2013).The per capita availability of protein in the India is 28 g/day, while WHO recommended it should be 80 g/day, consequently most serious problem of the malnutrition existing among the poor people, where most of the people have vegetarian diet and avoid the animal protein. So increase in productivity of pulse crop is very essential for proper nutrition balance. Hybrid breeding is one of those approaches in pigeonpea which offers a very good scope for enhancing the productivity. Pigeonpea represent first legume crop where hybrid technology has been exploited commercially.

Pigeonpea is a unique food legume because of its partial (20-30%) out crossing nature, which provides an opportunity to breed commercial hybrids. Saxena (2007) reported that CGMS based pigeonpea hybrids gave 50-100% yield advantage over the popular variety. Being a pulse, pigeonpea enriches soil through symbiotic nitrogen fixation and adds organic matter and other nutrients that make Pigeonpea an ideal crop for sustainable agriculture (Saxena, 2008).

Combining ability analysis is frequently employed to identify the desirable parents and crosses. Therefore, in the present study quest was made to identify the best combiners and desirable crosses. Line x tester analysis is an extension of top cross method in which several testers are used (Kempthorne, 1957) which provides

information about general and specific combining ability of parents.

MATERIALS AND METHODS

The experimental materials comprised of three CMS lines (ICPA2047, ICPA 2048 and ICPA2092) and ten testers (ICPL20093, ICPL20096, ICPL20098, ICPL20106, ICPL20108, ICPL20111, ICPL20123, ICPL20126, ICPL20129 and ICPL87119) obtained from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India. Thirty crosses were made in a line x tester fashion in *kharif*, 2012-13 and corresponding 30 F1's along with 13 parents were grown in Randomized Block Design with two replications during *kharif*, 2013-14. Each of the parents and F1s were sown in two rows of 4 meters length with a spacing of 75 x 30cm row to row and plant to plant. All recommended agronomic practices were followed to raise a good crop. Observations on five randomly selected competitive plants were recorded for days to 1^{st} flowering, days to 50 per cent flowering, days to maturity, plant height(cm), number of primary branches/plant, number of secondary branches/plant, number of pods/plant, number of grains/pod, 100-seed weight (g), grain yield/plant(gm) and pollen viability (%).The general combining ability (GCA) and specific combining ability (SCA) variances were worked out as per the method given by Kempthorne (1957).

RESULTS AND DISCUSSIONS

The analysis of variance (Table-1) revealed highly significant differences among the parents and hybrids for most of the yield traits indicating large parental diversity. The mean squires due to lines x tester interactions were found to be highly significant for number of primary branches/plant, number of secondary branches/plant, number of pod/plant, number of seed/pod,100 seed weight(gm), grain yield/plant(gm), pollen fertility % and non-significant for other characters. Variances due to lines were only significant for 100 seed weight.

General and Specific Combining Ability

The general combining ability (Table-2) revealed that among the testers, ICPL 20126 and ICPL 20108 were good general combiners for seed yield/plant. Among the testers, ICPL 20126(-2.93) and ICPL 20108(-0.60) exhibited negative GCA effect for days to first flowering with highly positive significant GCA effect for seed yield/plant. For days to maturity, ICPL 20123(-2.56) had highly significant negative GCA effect. For early maturating point of view, among of testers ICPL 20123(-2.56) had significant negative GCA effect for days to maturating, but it showed negative GCA effect for yield/plant (-15.20). Among the lines, ICPB 2047 had negative GCA effect for days to maturity with positive GCA value for yield/plant.

Therefore, simultaneous improvement in important yield components and other associated traits along with seed yield may be better approach for raising yield potential in Pigeonpea. Similar findings were also reported by Jahagirdar, (2003), Banu*et al*., (2006), Kumar *et al*., (2009), Vaghela*et al*., (2009) and Shoba and Balan, (2010).

The estimate of SCA effects of the hybrids are presented in Table-3.On the basis of specific combining ability four crosses were identified with positive and significant SCA effects for seed yield per plant. Most promising combinations for seed yield per plant were ICPA 2047 x ICPL 20126(29.87), ICPA 2048 x ICPL 20106(20.47), ICPA 2047 x ICPL 20108(14.62) and ICPA 2047 x ICPL 20098(14.18).SCA effect is generally considered the best criteria for selection of superior combinations for hybrid breeding. For earliness, hybrid ICPA 2047 x ICPL 20106(-4.95) showed highly significant negative SCA effect, whereas ICPA 2092 x ICPL 20126(-4.18), ICPA 2048 x ICPL 20108(-4.03) and ICPA 2092 x ICPL 20111(-3.68) showed significant negative SCA effect for days to maturity suggesting their importance

in development in early maturating hybrids.

Among the all the cross combinations, none of the hybrids showed positive significant SCA for plant height. Two hybrids, ICPA 2047 x ICPL 20123(-39.8) and ICPA 2048 x ICPL 20093(-26.98) depicted significant negative SCA effect for plant height. Hybrids ICPA 2048 x ICPL 87119(11.63), ICPA 2047 x ICPL 20098 (6.83), ICPA 2092 x ICPL 20111 (5.96), ICPA 2047 x ICPL 20126 (5.6), ICPA 2092 x ICPL 20108 (4.7) and ICPA 2048 x ICPL 20098 (4.69) were showed highly significant positive SCA effect for number of primary branches/plant. Three hybrids, ICPA 2047 x ICPL 20098(4.99), ICPA 2092 x ICPL 20106(4.89) and ICPA 2047 x ICPL 20126 (4.69) were showed highly significant SCA values for number of secondary branches/plant.

For pods/plant, ICPA 2048 x ICPL 87119 (102.9) was the best combiner (SCA) and ICPA 2047 x ICPL 20098(0.29) for number of seeds/pod and seven hybrids showed highly significant SAC effect for 100 seed weight. Among the all 30 hybrids, none of them emerged as good specific combination for all the yield contributing characters.

The critical examination of results would reveal that some crosses exhibiting high order significant and desirable SCA effects for different characters involved parents having different types of combinations of GCA effects such as high × high, high × low, and low × low. Pandey and Singh, (2002) have also observed involvement of high x high and low x high general combiner parent in manifestation of high order significant and desirable SCA effects for seed yield per plant and its components.

Pollen fertility (%) is an important character to evaluate the restoration of fertility and amount of viable pollens produced by particular hybrid which is a basic need for the successful production of high yielding CGMS-based hybrid of Pigeonpea. In present investigation out of 30 hybrids, 18 were showed positive SCA effect, whereas out of 10 tester, 6 showed positive GCA effect. So for fully exploitation of heterosis, hybrids should be good combiner for pollen fertility. Similar result reported by Wanjari*et al*. (2007).

The study clearly indicated that there was no particular relationship between positive and significant SCA effects of crosses with GCA effects of their parents for the characters under study and also supported by previous workers in pigeonpea (Khorgade*et al*., 2000; Pandey and Singh, 2002; Jahagirdar, 2003; Kumar *et al*., 2009; Shoba and Balan, 2010; Gupta *et al*., 2011; Kumar *et al*., 2012; Yarimani*et al*., 2013). The cross ICPA 2047 x ICPL 20126 showed highly positive significant SCA effect for grain yield/plant when both the parents also had positive GCA effect. It revealed the operation of non-additive gene effects. Similar results were also reported by Patil*et.al.*(2014) for grain yield.

CONCLUSIONS

The hybrid breeding programme in most of crops is primarily based on the concept of specific combining ability. On the basis of general combining ability the most promising parent was ICPA 2047 among the CMS lines. Four crosses, ICPA 2047 x ICPL 20126(29.87), ICPA 2048 x ICPL 20106(20.47), ICPA 2047 x ICPL 20108(14.62) and ICPA 2047 x ICPL 20098(14.18) were showed significant and desirable SCA effects for seed yield/plant may be considered for hybrid breeding programme. The development of synthetics and composites cultivars are also exploiting GCA (fixable component of genetic variance) and to some extent the SCA (non-fixable gene effects).

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Table 1: Analysis of Variance for Combining Ability (Line × Tester Analysis Including Parents)

Source of Variations	DF	Mean Sum of Squares										
		Days to First Flower	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	No. of Primary Branches/ Plant	No. of Secondary branches/ Plant	Pod / Plant	Seed/ Pod	100 Seed Weight (gm)	Grain Yield/Plant (gm)	Pollen Fertility %
Replication	1	1.16	9.11	37.77*	151.12	11.03	1.51	187	0.02	0.005	67.9	0.14
Genotypes	42	15.19**	17.55*	15.01**	500.17*	35.06**	33.26**	5219**	0.05*	1.76**	454.3**	134.25**
Crosses	29	9.81	11.82	11.37*	296.65	28.22**	16.71**	3405**	0.04	1.54**	244.9**	119.50**
Parents	12	23.63**	23.66**	24.96**	813.01**	5.96	24.21**	6948**	0.07**	2.26**	615.4**	0.61
Parents Vs. Hybrids	1	69.97**	110.36**	1.21	2647.94**	582.48**	621.92**	37096**	0.06	2.23**	4594.4**	2165.70**
Line	2	2.61	13.71	0.81	646.32	11.92	28.26	401	0.05	3.68*	85.7	69.13
Testers	9	15.15	23.62**	27.26**	381.92	25.81	11.80	5643	0.05	2.23	351.8	237.40*
Lines × Testers	18	7.95	5.71	4.59	215.17	31.24**	17.89**	2619**	0.03	0.96**	209.1**	66.16**
Error	42	6.30	8.68	6.20	257.78	6.25	5.63	718	0.02	0.11	76.2	6.77

*, ** Significant at P =0.05 and P = 0.01, respectively

Table 2: Estimates of General Combining Ability (GCA) Effects of 13 Parents for 11 Quantitative Characters in Pigeonpea

Sl. No	Tester	Days to First Flower	Days to 50% Flowering	Days to Maturity	Plant Height (Cm)	No. of Primary Branches/ Plant	No. of Secondary Branches/ Plant	Pod / Plant	Seed/ Pod	100 Seed Weight (gm)	Grain Yield/Plant (gm)	Pollen Fertility %
1.	ICPL 20093	-1.60	2.30	4.43**	-13.63*	-1.46	-0.97	-30.36**	0.045	0.85**	-1.57	-1.00
2.	ICPL 20096	1.23	-0.70	1.43	5.03	-0.93	0.12	-27.16*	0.09	0.01	-5.09	-13.41**
3.	ICPL20098	0.40	-1.53	0.60	2.53	2.83**	1.59	-15.39	0.07	0.07	2.40	4.01**
4.	ICPL 20106	2.40*	2.63*	1.93	5.20	-1.93	0.72	7.47	-0.04	0.29*	2.84	-0.34
5.	ICPL 20108	-0.60	-1.86	-1.56	11.53	2.60*	1.39	59.30**	0.037	0.20	9.62**	6.69**
6.	ICPL 20111	1.56	1.80	-0.56	5.36	1.96	0.29	29.97*	-0.11	-1.32**	-0.07	0.72
7.	ICPL 20123	0.73	0.96	-2.56*	-8.46	-0.96	-3.37**	-16.32	-0.17**	-0.71**	-15.20**	1.12
8.	ICPL 20126	-2.93**	-2.03	-1.40	-0.96	-0.76	-0.006	-6.52	0.08	-0.06	11.85**	4.42**
9.	ICPL 20129	-0.43	1.13	-0.40	2.70	-3.00**	-0.24	-30.38*	0.08	0.37**	-4.55	-7.83**
10.	ICPL 87119	-0.76	-2.70*	-1.90	-9.30	1.66	0.46	29.40*	-0.09	0.28*	-0.22	5.60**
	SE(gi)	1.02	1.20	1.01	6.55	1.02	0.96	10.93	0.06	0.14	3.56	1.06
	SE(gi-gj)	1.44	1.70	1.43	9.26	1.44	1.36	15.46	0.09	0.19	5.04	1.50
	Lines											
1.	ICPB 2047	0.23	-0.78	-0.21	-5.86	-0.73	0.84	2.81	-0.05	-0.25**	2.37	1.29*
2.	ICPB 2048	0.18	0.86	0.03	5.48	0.80	0.52	-5.16	0.05	0.49**	-0.98	-2.13**
3.	ICPB 2092	-0.41	-0.08	0.18	0.38	-0.06	-1.36*	2.34	0.004	-0.23**	-1.39	0.84
	SE(gi)	0.56	0.65	0.55	3.59	0.55	0.53	5.99	0.037	0.07	1.95	0.58
	SE(gi-gj)	0.79	0.93	0.78	5.07	0.79	0.75	8.47	0.05	0.10	2.76	0.82

*, ** Significant at P =0.05 and P = 0.01, respectively, SE(gi) = standard error due to lines, SE(gi-gj)= standard error due to testers.

Table 3: Estimates of Specific Combining Ability (SCA) Effects in 20 Hybrids for 11 Quantitative Characters in Pigeonpea

Sl. No.	Name	Days to First Flower	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	No. of Primary Branches/ Plant	No. of Secondary Branches/ Plant	Pod / Plant	Seed/ Pod	100 Seed Weight (Gm)	Grain Yield/Plant (Gm)	Pollen Fertility %
1.	ICPA 2047 x ICPL 20093	-0.40	1.95	0.71	1.53	-1.16	-2.20	-4.21	-0.21	-1.33**	-4.79	1.39
2.	ICPA 2047 x ICPL 20096	-2.40	-3.38	0.21	6.20	0.30	-4.90**	-32.54	0.20	-0.57*	-6.26	0.23
3.	ICPA 2047 x ICPL 20098	0.76	-3.21	3.21	6.86	6.83**	4.99**	-18.04	0.29**	-0.29	14.18*	3.51
4.	ICPA 2047 x ICPL 20106	3.76*	6.45**	4.05**	18.70	-4.29*	-4.14*	-49.47**	-0.07	1.13**	-5.69	-5.71**
5.	ICPA 2047 x ICPL 20108	-4.9**	-3.71	-2.45	10.86	-2.66	2.82	84.72**	-0.15	-1.01**	14.62*	2.87
6.	ICPA 2047 x ICPL 20111	1.43	0.45	0.21	3.03	1.40	-0.97	-6.54	0.04	0.42	-7.39	-1.13
7.	ICPA 2047 x ICPL 20123	0.93	-0.38	-4.95**	-39.8**	-0.63	-2.94	3.81	-0.38**	0.39	-7.76	3.22
8.	ICPA 2047 x ICPL 20126	-3.23	-0.05	-2.28	-1.63	5.60**	4.69**	93.28**	0.10	-0.65**	29.87**	17.04**
9.	ICPA 2047 x ICPL 20129	2.10	3.61	1.21	-0.63	-2.13	1.72	-87.25**	0.12	0.81**	-9.09	-22.34**
10.	ICPA 2047 x ICPL 87119	1.93	-1.71	0.05	-5.13	-3.26	0.92	16.25	0.04	0.39	-17.67**	0.90
11	ICPA 2048 x ICPL 20093	-0.18	2.30	2.46	-26.98*	1.96	0.11	37.76	0.012	0.40	6.88	13.15**
12.	ICPA 2048 x ICPL 20096	2.65	1.46	1.96	-8.98	-1.47	2.14	-78.60**	0.002	1.23**	-13.83*	-34.15**
13.	ICPA 2048 x ICPL 20098	2.98	1.13	0.80	13.01	4.69**	1.64	19.32	-0.06	-0.12	-1.46	2.63
14.	ICPA 2048 x ICPL 20106	5.15**	1.30	-1.03	14.68	-0.90	1.81	26.76	0.04	0.15	20.47**	0.60
15.	ICPA 2048 x ICPL 20108	-1.35	-1.53	-4.03*	10.85	2.26	0.41	1.02	0.21*	0.03	-10.84	7.40**
16.	ICPA 2048 x ICPL 20111	-1.68	-1.36	1.46	17.51	-1.70	2.11	32.02	-0.02	-0.31	4.90	4.01*
17.	ICPA 2048 x ICPL 20123	-0.68	2.30	-1.20	12.35	-3.83*	-2.82	-44.00*	-0.05	-1.57**	-17.33**	-1.29
18.	ICPA 2048 x ICPL 20126	-3.85**	-1.36	-1.70	-6.48	-6.00**	-3.45*	-45.20*	-0.07	-0.85**	4.03	1.29
19.	ICPA 2048 x ICPL 20129	-3.01	-1.20	1.96	-12.31	-6.63**	-3.15	-52.07**	0.16	1.28**	-4.98	-7.41**
20.	ICPA 2048 x ICPL 87119	-0.01	-3.03	-0.70	-13.65	11.63**	1.18	102.9**	-0.21*	0.45	12.15	13.76**
21	ICPA 2092 x ICPL 20093	-4.25**	2.58	3.65*	-9.38	-5.63**	-1.57	-51.71**	0.11	1.72**	-2.55	-7.17**
22.	ICPA 2092 x ICPL 20096	0.08	-2.75	2.31	-4.21	-4.26*	0.72	-67.08**	0.20	1.71**	-7.57	-13.38**
23.	ICPA 2092 x ICPL20098	0.08	-2.58	2.15	-5.55	1.70	1.76	5.77	0.008	-0.37	2.40	8.17**
24.	ICPA 2092 x ICPL 20106	-0.58	1.25	-1.18	0.11	0.13	4.89**	73.25**	-0.16	0.60	0.64	12.89**
25.	ICPA 2092 x ICPL 20108	2.25	0.41	1.15	-6.38	4.70**	-2.77	40.78*	-0.02	-0.42	10.22	-0.57
26.	ICPA 2092 x ICPL 20111	5.58**	5.58**	-3.68*	-0.38	5.96**	2.82	57.31**	-0.15	-1.93**	5.69	-6.96
27.	ICPA 2092 x ICPL 20123	4.75**	0.25	0.81	22.28	4.36*	-3.60*	22.55	-0.12	-1.43**	-14.17**	4.67*
28.	ICPA 2092 x ICPL 20126	-5.75**	-5.08*	-4.18*	-7.55	-1.86	-3.70	-32.58	0.09	-0.55*	1.50	4.68*
29.	ICPA 2092 x ICPL 20129	-2.08	0.08	0.31	12.61	-3.83*	2.39	-24.78	0.22	1.26**	6.05	-2.28
30.	ICPA 2092 x ICPL 87119	-0.08	0.25	-1.35	-1.55	-1.26	-0.94	-23.51	-0.18	-0.59*	-2.22	-0.04
	SE(Sij)	1.77	2.08	1.76	11.35	1.76	1.67	18.94	0.11	0.24	6.17	1.84
	SE(Sij-Ski)	2.51	2.94	2.49	16.05	2.50	2.37	26.79	0.16	0.34	8.73	2.60

*, ** Significant at P =0.05 and P = 0.01, respectively

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